Silica Fume: Its Role in Cement and Concrete Technology

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ABSTRACT

The role of silica fume as a cementitious by-product is reported, in terms of its historical and experimental aspects. Silica fume is found to be ≈100nm in size and therefore is the finest component ever to be used to make cements or concrete so far. Its average particle size when compared to that of Portland cement (≈10–15μm) is almost 100 times smaller in terms of the diameter size of the particle. Evidently, enhanced compressive strength from the use of silica fume was found. This is thought to be due to improved densification of the cement matrix.

Key words: Silica fume, By-products, Strength

INTRODUCTION

Since the development of Portland cement by Joseph Aspdin in 1824, there have been a number of developments through out the 20th century from the use of pozzolanic by-products in order to cut down the fuel cost and CO_2 emission in the manufacturing process. At the same time, turning waste to by-products, reusing of materials help reduce waste from industries, thus moving towards sustainable construction. The particle size of Portland cement (PC) itself is ≈10–15 μm where fly ash and ground granulated blast-furnace slag, two common by-products used through out the world, are also of around 10 μm (Neville, 1995; Malhotra and Mehta, 1996). Silica fume is a by-product from the ferrosilicon industry. It was first used in concrete in the early 1950's at the Norwegian Institute of Technology but its beneficial effects on concrete properties were not realized until early 1980's where silica fume was started to be used in concrete structures such as in the New Tjorn cable-stayed bridge in Sweden and in Kinzua dam in the USA (Federation International de la Precontriant, 1988; Khayat and Aitcin, 1993). Although its technical advantages is now being recognized more so than ever before, only a small percentage of the current supply of silica fume is being used as a mineral admixture in the cement and concrete industries (Malhotra and Mehta, 1996). One of the attractive characteristics of silica fume is its particle size which was reported to be approximately 100–500nm (Malhotra and Mehta, 1996; Federation International de la Precontriant, 1988).

Furthermore, it is known that cement improvement (also enhance the performance of concrete) depends on both physical and chemical properties, improved physical characteristics such as the use of finer particles (higher surface area) nonetheless has advantages in its own right in terms of filling the cement matrix, densifying the structure, resulting in higher strength and at the same time allowing faster chemical reactions to occur. In this work, physical characterization such as particle size and morphology of silica fume were carried out, using a Scanning Electron Microscope. Furthermore, the effect of silica fume on the compressive strength was also investigated.